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INVESTIGATION TO REMOVE THE SULPHIDES FROM KIDD CREEK MILL TAILING PRIOR TO CASSITERITE FLOTATION PROGRESS REPORT

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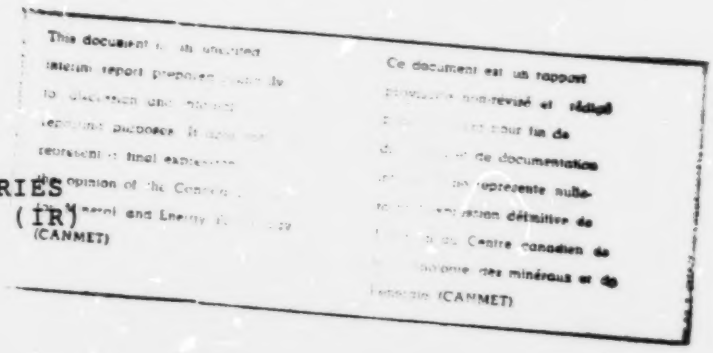

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INVESTIGATION TO REMOVE THE SULPHIDES FROM KIDD CREEK MILL TAILING PRIOR TO CASSITERITE FLOTATION

PROGRESS REPORT

by

M.A. Cristovici* and D.R. McCarthy**

ABSTRACT

Investigations were carried out to remove the sulphides from a Kidd Creek mill tailing sample, prior to tin flotation. Floating the sulphides from the ore at natural pH, followed by grinding the flotation tailing and second stage sulphides flotation, resulted in the removal of 95.8% of the sulphur contained in the original mill tailing. The sulphur content of the sample was thus reduced from 9.9% to approximately 0.6%.

Keywords: Flotation, cassiterite, sulphides flotation, cassiterite liberation, grinding

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ÉTUDE AYANT POUR OBJET L'EXTRACTION DES SULFURES CONTENUS DANS LES RÉSIDUS DE TRAITEMENT DE KIDD CREEK AVANT LA FLOTTATION DE LA CASSITÉRITE
RAPPORT SUR L'ÉTAT DES TRAVAUX

par

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RÉSUMÉ

Des études ont été effectuées dans le but d'extraire les sulfures d'un échantillon de résidus de traitement de Kidd Creek, avant la flotation de l'étain. La flottation dans une solution à pH naturel des sulfures contenus dans l'échantillon de minerai, suivie du broyage des résidus de flottation et d'une deuxième flottation des sulfures, ont permis d'extraire 95,8% du soufre contenu dans les résidus de traitement de départ. La teneur en soufre de l'échantillon a donc été réduite de 9,9% à environ 0,6%.

Mots-clés: Flottation, cassitérite, flottation des sulfures, libération de la cassitérite, broyage

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INTRODUCTION

Large amounts of tin are lost in the tailing of several Canadian base metal plants. Due to depressed tin market conditions, most of these plants have discontinued the production of tin concentrate. One of the main reasons for unprofitable tin operation of base metal plants was the low tin recovery.

Relatively fine sized tin minerals reporting in the base metal plant tails were processed by gravity concentration, which obviously failed to yield an acceptable metal recovery, because the efficiency of the method is quite low in the fine size range.

To improve the tin recovery, other methods of concentration more suitable for treating fine size particles, for instance flotation, were to be tried.

Recognizing the scientific and economic importance of tin recovery from base metal plant tails, CANMET initiated the present work. Since flotation appeared to be one of the best methods for concentrating fine tin particles, it was decided to investigate the recovery of tin minerals from base metal plant tails by flotation.

Many attempts have been made during the years to float cassiterite, the most common tin carrier, but success has been so far quite modest. More recently, newly developed collectors of amino-phosphonic groups have shown some encouraging results in cassiterite flotation. Consequently, these collectors were chosen for this work.

The ore sample chosen for this investigation was the flotation tailing of the Kidd Creek plant.

Since the Kidd Creek tailing contains some sulphide minerals in the form of pyrite, sphalerite, etc., it was necessary to find the optimum conditions for sulphide removal prior to cassiterite flotation. If not removed, these minerals will report in the cassiterite concentrate, deteriorating its grade.

The first part of the research work dealing with tin recovery was therefore carried out to determine the best conditions for sulphide removal. Following that, tin recovery will be investigated in the second stage of this testwork.

This progress report covers the results of the work carried out to remove the sulphides minerals prior to cassiterite extraction.

TESTWORK

OBJECTIVES

The objectives of this investigation were:

a) To determine the conditions for sulphide minerals removal prior to tin flotation;

b) To determine the tin minerals association and degree of liberation after sulphides removal.

ORE SAMPLE

An ore sample collected from Kidd Creek plant tailing was received for testwork.

The sample was prepared for chemical assay and testwork.

A. Chemical composition

The chemical composition of the tailing sample is presented in Table 1.

Table 1. Sample assay

Element	Assay %	Element	Assay %
Sn	0.09	Fe	14.38
S	9.94	CaO	1.68
Cu	0.12	MgO	3.22
Pb	0.12	SiO_2	53.22
Zn	1.16		

The tin content of the sample was quite low, less than 0.1%. The assay results for sulphur and base metals indicated the presence of sulphides minerals, mainly pyrite and/or phyrrhotite and some sphalerite.

B. Particle size and tin distribution

The ore sample was subjected to a screen analysis down to 38 μm. The screen undersize was further sized by a cyclosizer in the subsieve range to approximately 10 μm. All the size fractions were assayed to evaluate the tin distribution. The results of this work are given in Table 2.

Table 2. Particle size and tin distribution

Size		Size Distribution			% Tin in Indiv. Retained	
		% Retained		% Pass.		
Mesh	µm	Individ.	Cumul.	Cumul.	Assay	Distrib.
+100	147	2.1	2.1	97.9	0.01	0.2
150	104	7.3	9.4	90.6	0.02	1.8
200	74	4.8	14.2	85.8	0.02	1.2
270	53	12.5	26.7	73.3	0.04	6.0
400	38	10.4	37.1	62.9	0.06	7.4
	29	10.0	47.1	52.9	0.28	33.3
	21	7.9	55.0	45.0	0.11	10.4
	15	8.5	63.5	36.5	0.11	11.2
	11	6.4	69.9	30.1	0.09	6.9
	-11	30.1	100.0	-	0.06	21.6
	Total	100.0	-	-	0.08	100.0

SULPHIDES FLOTATION

When it is intended to recover the cassiterite by flotation. the sulphide minerals must be removed prior to tin extraction. Otherwise these minerals will float along with cassiterite deteriorating the grade of the tin concentrate.

Removal of sulphide minerals by flotation was tried under two variants:

- Flotation of fine ground ore
- Flotation without grinding

A. Flotation of fine ground ore

The ore tailing sample was ground to 100% -38 µm and then the sulphides minerals, mainly pyrite-pyrrhotite and sphalerite were floated at natural, acid and alkaline pH. In some tests, sodium sulphide was also used to activate the flotation of presumably oxidized minerals. Potassium amylxanthate was used as collector. Among several frothers tried, pine oil proved to be more effective.

Detailed conditions and results of these tests are kept on file. A summary of the most significative test results are presented in Table 3.

Table 3. Sulphides flotation from fine ground ore

Conditions						Results			
pH	Reagents, kg/t					Concentrate			Tails
	H_2SO_4	Na_2CO_3	Na_2S	Xanth.	Pine Oil	Wt%	Assay % S	% Dist. S	Assay % S
6.6*	-	-	-	0.450	0.180	17.0	36.30	63.6	4.26
5.9	1.840	-	-	0.450	0.180	17.8	35.13	63.7	4.34
5.5	5.520	-	-	0.450	0.180	18.6	6.58	70.3	3.54
9.4	-	6.250	-	0.200	0.180	19.7	39.74	82.5	2.07
9.3	-	6.250	0.200	0.200	0.180	24.2	32.35	85.0	1.83

* Natural

The best results, in terms of sulphides removal, were achieved in alkaline pH. Sodium sulphide addition has somewhat increased the sulphur extraction in the concentrate.

B. Flotation without grinding

The sulphides were floated from the ore sample in the as received state, under natural, acid and alkaline pH. Same reagents were used as in the previous series of tests.

Again, detailed conditions and results of these tests are kept on file, while Table 4 summarizes the data.

Table 4. Sulphides flotation without grinding

Conditions						Results			
pH	Reagents, kg/t					Concentrate			Tails
	H_2SO_4	Na_2CO_3	Na_2S	Xanth.	Pine Oil	Wt%	Assay % S	% Dist. S	Assay % S
4.8*	-	-	-	0.450	0.156	26.5	32.67	90.3	1.27
4.8%	-	-	-	0.450	0.156	27.5	31.36	90.9	1.19
4.5	1.840	-	-	0.450	0.156	25.5	34.66	88.2	1.59
9.2	-	22.5	-	0.450	0.156	23.6	35.64	86.9	1.66
9.4	-	22.5	0.100	0.450	0.156	25.2	33.94	88.4	1.50

* Natural

Without grinding, the sulphides (pyrite and sphalerite) floated faster and the sulphur recovery was higher than that obtained when the ore was ground prior to flotation.

Among the flotation conditions without grinding it appeared that the natural pH gave the best sulphur recovery, i.e. over 90%.

Therefore, the best conditions for sulphides removal in preparation of tin flotation were:

- No grinding
- pH: natural
- K amylxanthate: 450 g/t
- Pine oil 156 g/t

Under these conditions, approximately 90% of the sulphur contained in the ore was removed leaving a material with a content of about 1.2% S.

C. Grinding for tin recovery and additional sulphides flotation

In preparation for cassiterite recovery the sulphide flotation tailing was thickened and ground to 100% - 38μm.

A Nagahm flotation machine was chosen to be used for cassiterite recovery. However, before tin flotation an additional removal of the remainder of sulphides was performed in the Nagahm cell. The supplementary sulphides

flotation took place in acid pH only, since the succeeding cassiterite flotation was also intended to be carried out in the same pH range.

The results of the second stage sulphides flotation are summarized in Table 5.

Table 5. Additional flotation of sulphides

Conditions				Concentrate					Tails
pH	Reagents, kg/t*			% Weight		Assay	% Dist., S.		Assay
	H_2SO_4	Xanthate	Pine Oil	Individ.	Overall	% S	Individ.	Overall	% S.
5.7	920	80	36	12.0	8.8	5.73	54.1	5.3	0.66
5.7	920	80	36	13.0	9.4	5.80	62.9	5.7	0.51

* tonne of original tailing sample

The second stage sulphides flotation removed an additional 5.5% of the sulphur contained in the tailing sample, lowering the sulphur content of the cassiterite flotation feed to approximately 0.6%.

MINERALOGY OF SULPHIDES FLOTATION TAILING

The tailing obtained after floating the sulphides from the fine ground ore (100% - 38 μm) was submitted to mineralogical examination to determine the presence of the remaining sulphides and to evaluate the liberation of the cassiterite.

The conclusions of this study were:

a) Most of the sulphur left in the sample occurred as constituents of pyrite and pyrrhotite, both minerals exhibiting grains that were largely free.

b) About half of the cassiterite was totally free and about 80% of the mineral was in particles that contain more than 70% cassiterite.

c) A regrind of 100% - 18 μm would be required to increase cassiterite liberation

CONCLUSIONS

The testwork carried out to determine the best conditions for sulphide minerals removal prior to cassiterite flotation and to evaluate the liberation of tin minerals after the sulphides removal led to the following conclusions:

a) By two stage sulphides removal, about 95% of the sulphur contained in the tailing sample was eliminated reducing the sulphur content of the ore from over 9% to about 0.6%.

b) Mineralogical examination of the sulphide flotation tailing indicated that more advanced grinding is required, namely 100% - 18 μm, for a good cassiterite liberation.

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